	PAT-NO	ISSUE-DATE	PATENTEE-NAME	US-CL
☐	4587941	May 1986	Mishina et al.	123/550
☐	4627405	December 1986	Imhof et al.	123/549
☐	5224456	July 1993	Hosoda et al.	123/520
☐	5315975	May 1994	Hattori et al.	123/337
☐	5322043	June 1994	Shriner et al.	123/306
☐	5394857	March 1995	Yamakawa	13/686
☐	5465701	November 1995	Hunt	123/531
☐	5482023	January 1996	Hunt et al.	123/491
☐	5529035	June 1996	Hunt et al.	123/179.15

OTHER PUBLICATIONS

SAE 880558, Nogi et al.; Mixture Formation of Fuel Injection Systems in Gasoline Engines; Feb. 29-Mar. 4, 1988.

ART-UNIT: 377

PRIMARY-EXAMINER: Wolfe; Willis R.

ASSISTANT-EXAMINER: Vo; Hieu T.

ATTY-AGENT-FIRM: Gifford, Krass, Groh, Sprinkle, Anderson & Citkowski, P.C.

ABSTRACT:

An apparatus for reducing noxious gases in the exhaust emissions of an automobile is disclosed. During engine cold start, a cold start injector having a heater downstream of the injector outlet vaporizes fuel so that a leaner air-fuel mixture can be used, thereby reducing engine emissions before the engine and catalytic converter warm up. The heater includes various configurations for swirling the fuel and exposing it to large surface areas for improving the vaporization of the fuel. A tapered bore surrounding the throttle allows for precise air flow control into the cold start device during engine warm-up.

36 Claims, 23 Drawing figures
Exemplary Claim Number: 1
Number of Drawing Sheets: 14

BRIEF SUMMARY:

FIELD OF THE INVENTION

The present invention relates generally to cold start devices used with internal combustion engines, and in particular to an apparatus and method for vaporizing the fuel ejected from a cold start injector by delivering the fuel through a heated chamber prior to the intake valve of a cylinder head.

BACKGROUND OF THE INVENTION

The increase in atmospheric pollution generated by exhaust emissions from conventional gasoline and diesel powered internal combustion engines have caused both federal and state governments to enact laws and establish regulations which impose even greater restrictions on the performance of motor vehicles in the areas of exhaust gas emission and fuel economy. For example, the ULEV FTP 75 standards for gasoline engines that are to take effect in the next few years call for double digit reductions in the levels of noxious emissions over the 1990 ULEV FTP standards (up to 90% in the case of hydrocarbons).

During the start of a cold engine, and before the catalyic converter can warm up to be effective, engine emissions are particularly high. After warm-up and during normal running, the catalytic converter reduces emissions, and the internal combustion engine usually operates at a 14.7:1 air to fuel mixture ratio which also yields reduced emissions. However, when the engine temperature is below a certain point, it is more difficult for all of the fuel to be vaporized, and a choke factor is needed to supply extra fuel. Otherwise, not enough fuel will be vaporized, resulting in a mixture leaner than the desired 14.7:1 stoichiometric ratio. Typically, the first twenty seconds of engine startup operates in a cold start "enrichment" mode in which a richer than stoichiometric air/fuel mixture is delivered. As the engine heats up to normal operation, the additional fuel supplied in the air/fuel mixture is gradually decreased until the desired stoichiometric ratio is reached and the engine is running smoothly.

During the cold start enrichment mode, the increased amount of fuel delivered to the combustion chamber causes an increase in hydrocarbon and nitrous oxide emissions due to incomplete burning of the fuel. At the present levels of allowable hydrocarbon emission, the cold start enrichment mode uses an air/fuel ratio of about 10:1 through 14:1, producing emissions that do not exceed today's standards of 7.0, 0.39 and 0.40 grams/mile for CO, HC/NMOG and NOx. These levels of emissions, however, will have to be reduced to 1.7, 0.040 and 0.20 grams/mile respectively to meet the U.S. government's ULEV FTP 75 emissions regulations in the near future. This represents a 90% reduction in HC emissions over present levels.

Heretofore, manufacturers have provided a number of devices to warm the engine faster and to make the choke more sensitive. However, these devices have been too slow or too complicated to effectively meet upcoming ULEV FTP 75 regulations during that short cold start duration period. Furthermore, catalytic converters provide almost no assistance to reducing emission levels during the cold start period. Thus, what is needed is an uncomplicated apparatus for enabling smooth engine operation during cold starts that produces engine emissions that will meet the U.S. government's future ULEV FTP 75 regulations requirements.

Accordingly, it is an object of the present invention to provide a cold start apparatus which can reduce the amount of excess fuel needed during cold start procedures.

It is also an object of the present invention to provide a cold start apparatus which can reduce the exhaust emissions of an internal combustion engine during cold start operation so as to meet the requirements under the upcoming ULEV FTP 75 regulations governing exhaust emissions.

It is a further object of the present invention to reduce the overall fuel consumption of an internal combustion engine.

It is another objective of the present invention to provide a cold start apparatus that includes self cleaning mode which reduces maintenance requirements.

It is still another object of the present invention to accomplish the above-stated objects by utilizing an apparatus which is simple in design and use, and economical to manufacture.

The foregoing objects and advantages of the invention are illustrative of those which can be achieved by the present invention and are not intended to be exhaustive or limiting of the possible advantages which can be realized. Thus, these and other objects and advantages of the invention will be apparent from the description herein or can be learned from practicing the invention, but as embodied herein or as modified in view of any variations which may be apparent to those skilled in the art. Accordingly, the present invention resides in the novel methods, arrangements, combinations and improvements herein shown and described.

SUMMARY OF THE INVENTION

In accordance with these and other objects of the invention, a brief summary of the present invention is presented. Some simplifications and omissions may be made in the following summary, which is intended to highlight and introduce some aspects of the present invention, but not to limit its scope. Detailed descriptions of a preferred exemplary embodiment adequate to allow those of

ordinary skill in the art to make and use the inventive concepts will follow in later sections.

According to a broad aspect of the invention, an apparatus for vaporizing fuel before it is supplied to a cylinder of a multi-cylinder internal combustion engine is disclosed. The multi-cylinder engine includes a fuel supply, and an air intake passageway having a throttle valve having a pivotally secured throttle plate disposed therein. The cold start apparatus includes (i) a housing fluidly coupled on one end to the air intake passageway downstream of the location of the throttle; (ii) a cold start fuel injector having an outlet and disposed in the housing; (iii) an idle air conduit fluidly coupled on one end to the air intake passageway, and fluidly coupled on the other end to the housing for delivering air adjacent to the outlet of the cold start fuel injector for intermixing air with fuel ejected from the cold start fuel injector; and (iv) a heated chamber having a longitudinal lumen and disposed at the outlet of the cold start fuel injector for vaporizing the air-fuel mixture before it is delivered to the engine cylinder. The heating chamber includes a plurality of independent heating element sections that can be separately controlled to vary the temperature across the heating chamber.

A method is also disclosed for reducing automobile exhaust emissions during the cold start of a multi-cylinder internal combustion engine having a fuel supply, a plurality of fuel injectors located adjacent to separate engine cylinders, a cold start fuel injector and heater fluidly coupled to the engine cylinders, and an air passageway having a pivotally secured throttle valve disposed therein. The method includes the steps of (i) initiating power to the heater for a period of time before the engine is started; (ii) supplying the fuel to the engine cylinders through the cold start injector; (iii) mixing the fuel from the cold start injector with air at an amount sufficient to produce a substantially stoichiometric ratio of the air to fuel; (iv) passing the substantially stoichiometric air-fuel mixture over the heater element to cause the fuel to be vaporized; (v) supplying the vaporized air-fuel mixture to the engine cylinders when the engine is started, and until the engine reaches a temperature of about 60.degree. C.; and (vi) switching from fuel supplied by the cold start injector to fuel supplied by the plurality of fuel injectors after the engine reaches a pre-established threshold as measured by temperature, time or a combination of both.

DRAWING DESCRIPTION:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective diagram illustrating a preferred embodiment of the cold start device of the present invention mounted on an internal combustion engine.

FIG. 2 is a perspective diagram of a cross-sectional view of a preferred embodiment of the cold start device of the present invention.

FIG. 3 is a perspective diagram of a cross-sectional view of one embodiment of a fuel heater according to the present invention.

FIG. 4 is a perspective diagram of a cross-sectional view of another embodiment of a fuel heater according to the present invention.

FIG. 5 is a perspective diagram of a cross-sectional view of yet another embodiment of a fuel heater according to the present invention.

FIG. 6 is a perspective diagram of a cross-sectional view of still another embodiment of a fuel heater according to the present invention.

FIG. 7 is a block form diagram of the control systems of a cold start device, according to the present invention.

FIG. 8 is a flow diagram of the overall operation of a preferred embodiment of the cold start device of the present invention.

FIGS. 9 and 10 are graphical form diagrams representative of the operation of the cold start device over varying temperatures.

LITIGATION SEARCH US 5,894,832 (09/839,837)

```
  QUESTEL-ORBIT:
  Selected cluster : LEGAL
  Databases : LGST, CRXX, PAST, LITA

?us5894832/pn

  Term not in index/PN-LITA : US5894832

  LGST                        1
  CRXX                        1
  PAST                        2
  LITA                        0

  1/4 LGST (1/1) - (C) LEGSTAT
  PN  - US 5894832  [US5894832]
  AP  - US 931172/97  19970916  [1997US-0931172]
  DT  - US-P
  ACT - 19970916  US/AE-A
        APPLICATION DATA (PATENT)
        (US 931172/97  19970916  [1997US-0931172])
      - 19990420  US/A
        PATENT
      - 20000104  US/CC
        CERTIFICATE OF CORRECTION
      - 20010904  US/RF
        REISSUE APPLICATION FILED
        20010420
  UP  - 2001-40

  2/4 CRXX (1/1) - (C) CLAIMS/RRX
  AN  - 3137585
  PN  - 5,894,832 D  19990420  [US5894832]
  PA  - Hitachi America Ltd
  PT  - M (Mechanical)
  ACT - 20010420  REISSUE REQUESTED
        ISSUE DATE OF O.G.: 20010904
        REISSUE REQUEST NUMBER: 09/839837
        EXAMINATION GROUP RESPONSIBLE FOR REISSUEPROCESS: 3747
        Reissue Patent Number:
  UP  - 2000-01
  UACT- 2001-09-04

  3/4 PAST (1/2) - (C) PAST
  AN  - 200136-001235
  PN  - 5894832  A  [US5894832]
  DT  - A (UTILITY)
  OG  - 2001-09-04
  CO  - REA
  ACT - REISSUE APPLICATION FILED
  SH  - REISSUE APPLICATION FILED

  4/4 PAST (2/2) - (C) PAST
  AN  - 200001-000091
  PN  - 5894832  A  [US5894832]
  DT  - A (UTILITY)
```

OG - 2000-01-04
CO - COR
ACT - CERTIFICATE OF CORRECTION
SH - CERTIFICATE OF CORRECTION

****

LEXIS and NEXIS:
ALL PATENT FILES

PATNO IS 5894832

Your search request has found 1 PATENT through Level 1.

LEVEL 1 - 1 OF 1 PATENT

<5,894,832>

<<=2>> GET 1st DRAWING SHEET OF 14

Apr. 20, 1999

Cold start engine control apparatus and method

REISSUE: Reissue Application filed Apr. 20, 2001 (O.G. Sep. 4, 2001) Ex. Gp.: 3747; Re. S.N. 09/839,837

CORE TERMS: engine, fuel, cold, heater, injector, 1-f, emission, idle, exhaust, throttle...
>>>
CASES:

Your search request has found no CASES.

JOURNALS:

Your search request has found no ITEMS.

NEWS STORIES:

Your search request has found no STORIES.

****

DIALOG INFORMATION SERVICES

File 345:Inpadoc/Fam.& Legal Stat 1968-2001/UD=200140
(c) 2001 EPO

S1 1 PN="US 5894832"

1/39/1
DIALOG(R)File 345:Inpadoc/Fam.& Legal Stat

15124612
Basic Patent (No,Kind,Date): US 5894832 A 19990420 <No. of Patents: 001>

Patent Family:

Patent No	Kind	Date	Applic No	Kind	Date	
US 5894832	A	19990420	US 931172	A	19970916	(BASIC)

Priority Data (No,Kind,Date):
US 931172 A 19970916
US 679273 B1 19960712

PATENT FAMILY:
UNITED STATES OF AMERICA (US)
Patent (No,Kind,Date): US 5894832 A 19990420
COLD START ENGINE CONTROL APPARATUS AND METHOD (English)
Patent Assignee: HITACHI AMERICA LTD RESEARCH A (US)
Author (Inventor): NOGI TOSHIHARU (JP); HUNT FRANK W (US)
Priority (No,Kind,Date): US 931172 A 19970916; US 679273 B1 19960712
Applic (No,Kind,Date): US 931172 A 19970916
National Class: * 123491000; 123179150; 123549000
IPC: * F02M-051/00; F02D-041/06
Derwent WPI Acc No: * G 99-276303; G 99-276303
Language of Document: English

UNITED STATES OF AMERICA (US)
Legal Status (No,Type,Date,Code,Text):

US 5894832	P	19960712	US AA	PRIORITY
			US 679273 B1	19960712
US 5894832	P	19970916	US AE	APPLICATION DATA (PATENT)
			(APPL. DATA (PATENT))	
			US 931172 A	19970916
US 5894832	P	19990420	US A	PATENT
US 5894832	P	20000104	US CC	CERTIFICATE OF CORRECTION
US 5894832	P	20010904	US RF	REISSUE APPLICATION FILED
			(REISSUE APPL. FILED)	
			20010420	

****